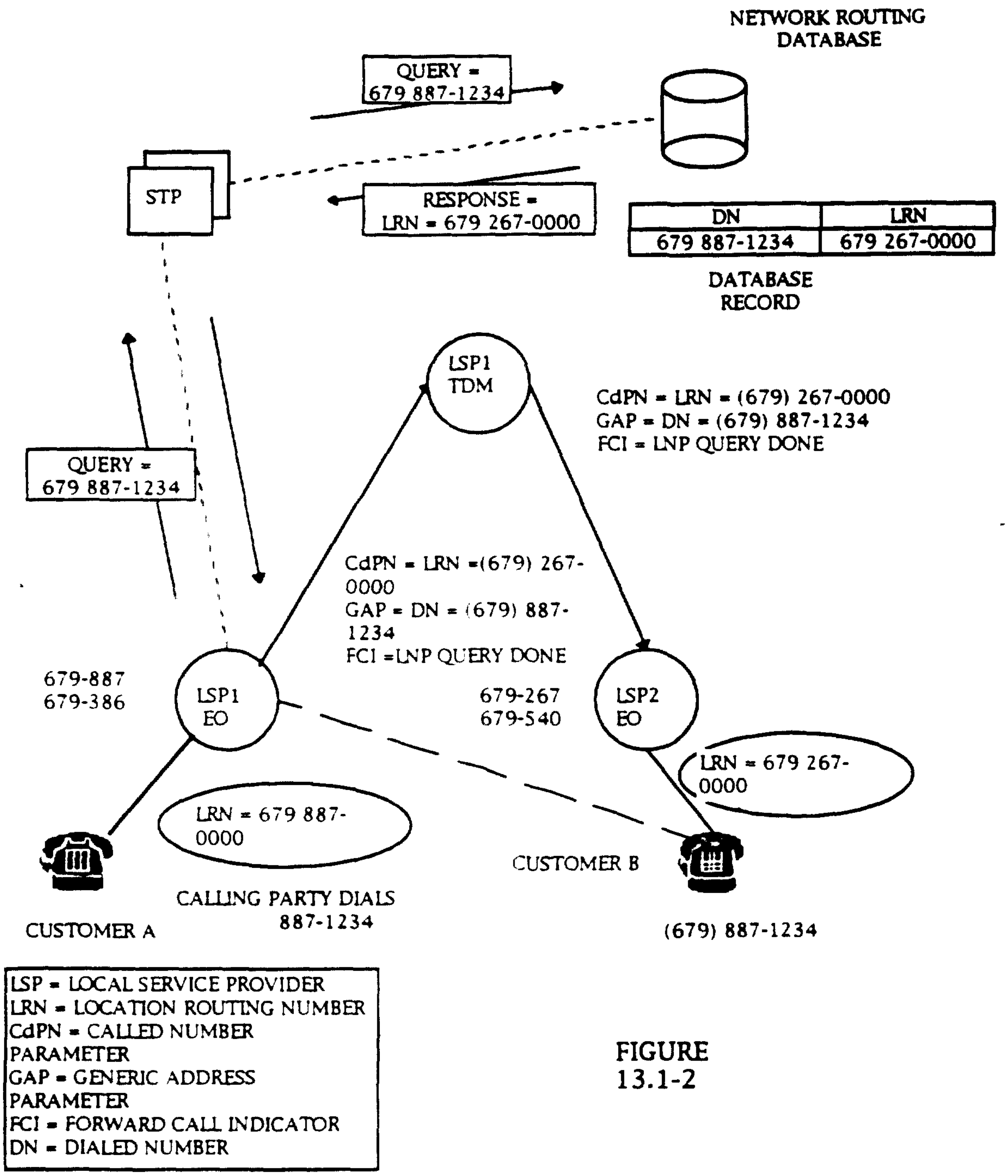
NETWORK ROUTING
DATABASE
QUERY =
679 887-1234
STP
RESPONSE =
LRN = 679 267-0000
DN
LRN
679 887-1234
679 267-0000
DATABASE
RECORD
LSP1
TDM
CdPN = LRN = (679) 267-0000
GAP = DN = (679) 887-1234
FCI = LNP QUERY DONE
QUERY =
679 887-1234
CdPN = LRN =(679) 267-
0000
GAP = DN = (679) 887-
1234
FCI =LNP QUERY DONE
679-887
679-386
LSP1
EO
679-267
679-540
LSP2
EO
LRN = 679 267-
0000
LRN = 679 887-
0000
CUSTOMER B
CALLING PARTY DIALS
887-1234
CUSTOMER A
(679) 887-1234
LSP = LOCAL SERVICE PROVIDER
LRN = LOCATION ROUTING NUMBER
CdPN = CALLED NUMBER
PARAMETER
GAP = GENERIC ADDRESS
PARAMETER
FCI = FORWARD CALL INDICATOR
DN = DIALED NUMBER

FIGURE
13.1-2

i. Calling party A, served from LSP1 EO dials 887-1234, a 7 digit local call.

ii. LSP1 receives and analyzes the dialed digits and determines that the call is local and, therefore, is not to be handed off to the presubscribed carrier.

iii. The LSP1 EO tests to determine if this is an intraswitch call by checking the NXX and the line number. If the line number is resident in the switch, the call is completed in the normal manner.

iv. If the line number is not found, the NPA-NXX of the dialed number will be examined to determine if this is a portable code. If the code is portable, the 7 digit dialed number will be prefixed with the NPA and a 10 digit query (679 887-1234) launched to the routing database.

v. The routing database returns the LRN (679 267-0000) associated with the dialed number (DN) to the LSP1 EO. LSP1 uses the LRN to route the call.

vi. The LSP1 EO makes an AMA record for the call. The terminating LRN, along with the dialed number, is included in the AMA record.

vii. In this example LSP1 is not directly connected to LSP2. The necessary routing, therefore, points to the LSP1 tandem office. The LSP1 EO formulates a SS7 call set-up message (ISUP IAM) with the LRN in the CdPN parameter, the dialed number in the GAP, and the FCI set to indicate that the query has been performed, and routes the call to the LSP1 tandem.

viii. The LSP1 tandem switch examines the contents of the CdPN parameter and determines that it is not its own LRN (if the tandem switch also functioned as a end office it would be assigned an LRN), and forwards the call, based upon the LRN, to the LSP2 EO along with the SS7 IAM it received.

ix. The LSP1 EO analyzes the digits received in the CdPN parameter of the call set-up message, determines that it serves the NPA-NXX and identifies the line number as its LRN. The LSP1 EO therefore recognizes that it must examine the GAP to obtain the original dialed number and uses that number to complete the call to the called party B.

13.1.3.3.1 InterLATA Calls

Similar call processing would be used to complete an interLATA call. The primary distinction here is that the originating switch -- the switch serving the calling party -- would identify the call as interLATA and forward the call to the presubscribed carrier. A switch in the interexchange carrier (IC) network would identify the dialed number as a potential ported call, launch the database query, formulate the appropriate signaling message based upon information (i.e., the LRN) returned from the routing database, and route the call.

13.1.3.3.2 Intraoffice Calls

As indicated previously, intraoffice calls can be completed without the need for a database query. This capability is derived from the fact that the LRN proposal identifies customers using only the customer number; that is, the number dialed to reach that customer. Accordingly, upon the origination of a call and receipt of the dialed digits, a serving end office can determine, without the need for a query to the number portability routing database, if the specific line number is resident in that office.

13.1.3.3.3 Calls Involving Non-LNP Capable Switches

There may be switches which do not have the capability to identify portable NPA-NXXs and launch the necessary query to a network routing database. Those switches will route calls in the normal manner allowing a subsequent switch in the call path, upon recognition that an LNP query has not been performed and that the dialed number contains a portable NPA-NXX, to obtain the LRN and appropriately route the call.

In addition, it is possible that a number could be ported to a switch which is non-LNP capable and therefore unable to identify its LRN and retrieve the dialed number from the GAP. In this situation, the switch routing the call to the non-LNP capable switch will recognize (based upon trunk group identification) that it must not send the LRN in the CdPN parameter, but instead forward the orignal dialed number.

13.1.3.3.4 MF Interworking

Although LRN, as do most number portability proposals, bases call processing on the availability of SS7, LRN can accommodate MF interworking and provide call completions to ported numbers served from end offices which do not support SS7. Specifically, consider a network switch which recognizes the FCI, identifies the call as completing to a ported number, and routes that call using the LRN. If, in selection of the route it is recognized that the trunks linking that switch with the end office serving the ported number are MF, and therefore, cannot accommodate the necessary use of the SS7 CdPN and GAP parameters, the switch will obtain the original dialed number from the GAP and forward that number to the end office using in-band (MF) signaling.

13.1.3.3.5 Default Routing

In the unlikely situation where a database failure is encountered and network routing information cannot be obtained by an originating or intermediate switch, the LRN proposal supports the use of default routing which will route the call to the end office switch to which the dialed NPA-NXX was originally assigned. Such calls will be forwarded indicating no database query was performed, allowing the terminating switch to launch its own query in an attempt to obtain the LRN.

13.1.4 NETWORK IMPACTS

As may be evident in the description of the call flows, some of the necessary call processing capabilities are not presently available and will therefore require network development. Among the areas impacted will be processing in network switches, the use of existing signaling parameters, and the need for routing databases.

13.1.4.1 Switching

The use of the LRN as a 10 digit, NANP number allows the continued use of existing routing algorithms and routing tables. Development is required, however, to accommodate the need for terminating switch or GAP processing; that is, the ability of a switch to identify its LRN, and upon that identification obtain the original dialed number from the GAP. Further development may be required if a given end office can complete calls to only a limited number of NXXs, and the number of NXXs in a designated portable area that might be open on that switch exceeds the current limit.

The LRN architecture supports a flexible implementation of switch triggers, allowing the use of either AIN or IN technology. Existing capabilities might be deployed in some cases, depending on the specific switch technology. It is recognized however, that in some current implementations, available AIN triggers which might be used to launch the necessary database queries, can potentially interfere with other existing features. Accordingly, it is suggested that new local number portability (LNP) triggers, either AIN or IN based, be developed to accommodate number portability without the concern of feature interaction.

13.1.4.2 Signaling

The LRN proposal involves the use of existing SS7 parameters, and therefore does not require the lengthy standards process that might be involved in establishing new parameters. LRN does, however, add to the current uses of certain of these existing parameters and does demand some effort in standards to accommodate the necessary changes in documentation. As previously explained, specific changes will place the LRN in the CdPN parameter, the original dialed number in the GAP, and use the FCI to indicate that an LNP query has been performed. The documentation effort is currently underway in the appropriate standards body (T1S1).

13.1.4.3 Database Requirements

Requirements associated with both the network routing databases and the SMS are not unique to the LRN proposal and have been discussed previously in Sections 7.1.2 and 7.1.5. At minimum, the database record will contain the LRN for each ported number, but may also contain rating information (v&h coordinates) or specific service provider identification. Information associated with call rating, such as v&h coordinates, would only be necessary if location portability were extended beyond rate center boundaries, and the calling and called party numbers no longer accurately identified the repsective rate centers.

Requirements associated with database capacity and its support of a given number of transactions are dependent upon the volume of portable numbers in the area served by the database. Questions have been raised concerning whether the database might contain all numbers within portable codes or just those numbers which have been ported. Answers to these questions are largely dependent on the type number administration selected. In any event, LRN can be adapted to either scenario.

13.1.4.4 Networks Involved

Within an area in which there exist portable codes, the networks of LSPs who provide service in that area and ICs who choose to terminate calls to end offices in that area could be impacted. As indicated earlier, however, under the LRN proposal, those carriers who choose not to modify their networks or are unable to do so, can continue to process calls to ported numbers by forwarding trafffic originating in or transiting through their networks based upon default routing – the routing of the call based upon the assumption that the dialed number continues to be served from the end office originally assigned the NPA-NXX. In this manner, the FCI will not be set, and subsequent switches in the call path, which are number portability capable, can recognize a potentially portable number and effect the necessary database query and associated call processing.

13.1.5 SERVICE IMPACTS

It is necessary that any proposed architecture for the support of number portability maintain the availability of all services. Those services which are of particular interest include CLASS services, operator services, and emergency services. The LRN architecture permits the continued provision of these services.

13.1.5.1 CLASS Services

Customized Local Area Signaling Services (CLASS) such as Auto Call-Back and Auto Recall rely largely on the knowledge of calling and called party numbers and the use of common channel signaling (SS7) non-call associated signaling messages. With LRN, both calling and called party numbers are readily available. However, the six digit (global title) translations (GTT), based upon NPA-NXX, used to direct non-call associated signaling messages to the proper end office cannot provide the necessary routing in a portable environment. Rather, some form of 10 digit GTT is required. Although 10 digit GTTs in the STP is conceivable, the volume of numbers that might be accommodated in this manner is limited, and the adminiistrative effort necessary to maintain LNP data in STPs could be burdensome. Consequently, 10-digit GTT in STPs should only be considered as an interim arrangement. An alternative might first require a query to the number portability database which would retrieve the LRN associated with the number. The LRN could then be used to support the TCAP CLASS query using existing (six-digit) signaling network functionality. Another option, apparently preferred by some switch vendors, would direct the TCAP CLASS query to the LNP database where information (e.g. a destination point code) could be obtained from the database record and the query passed directly to its appropriate destination.

13.1.5.2 Operator Services

Operators often need to have access to the ported calling and called numbers to properly interact with customers. With the LRN proposal, the ported calling number, rather than the network address, will always be forwarded to the operator services platform. Accordingly, on operator handled calls (e.g., 0+) no LNP query need be performed prior to the call being sent to the operator system. Rather, the operator services platform will itself perform the query in order to obtain the necessary routing information.

In addition to completion of 0+ calls, other operator services require that routing information be available at the operator services platform. Included are all inward services which are necessarily routed to a specific operator services location. One such service is Busy Line Verification (BLV). BLV allows an operator, accessed by the calling party, to verify the status (busy/out of service) of a given customer number. Such services are currently implemented based upon a six digit translation of the NPA-NXX of the customer number. Clearly, in a portable environment, this type translation is insufficient to route the call to the operator platform of the LSP which serves a ported called party. Operator services platforms will properly route these calls after accessing the number portability routing database and obtaining the LRN for the given customer number.

In addition to services which require routing to a specific operator services platform, alternate billed calls which route through the operator services switch will also be impacted by number portability. Validation of credit card calls, which use telephone number based calling cards, as well as the verification of requests for collect and bill-to-third requires knowledge of the LIDB where the line information resides. Again, in a portable environment the current NPA-NXX based LIDB identification is not sufficient, and a query to the number portability database would be necessary to perform the 10-digit GTT necessary for validation or verification. The ready avialability within the LRN architecture of both calling and called party number supports these functions.

13.1.5.3 Services Using Non-Geographic Numbers

Several types of services use non-geographic numbers such as 500, 700, 800, 900, etc., and require a network based look-up, usually in the form of a database query, to obtain routing information to complete the call. It is possible that the routable number itself has been ported and that call processing therefore requires a query to the LNP routing database to identify an LRN and properly direct the call. Accordingly, the query to the LNP database should be done as the last activity prior to call routing.

13.1.6 END USER IMPACTS

Clearly, any architecture selected to support number portability should provide that capability with minimal, if any, impact on an end user, both the customer who ports their number as well as the customer who calls that ported number. That is, in areas in which number portability has been implemented, all users should continue to be able to dial numbers in the familiar manner and receive all services currently provided. In addition, if a number is ported, but remains at the same location, or a location within the same rate center, the architecture must provide the capability to ensure that calls made to that number are not subject to increased charges.

13.1.6.1 Transparency

The LRN proposal will provide number portability without adverse impact to the end user. Calls to ported numbers should be completed with minimal increase in post dial delay (no more than one-half second) and the proper customer number will be displayed if the called party uses Caller ID. Moreover, CLASS features such as Auto Call Back and Auto Recall can be supported and all operator services will continue to be available in the normal manner. In addition, although AT&T suggests that location portability initially be limited to within rate centers to avoid possible rating complexities, the LRN proposal, with the appropriate call detail recording, could accommodate accurate call rating even with an expanded location portability scenario.

13.1.6.2 Ubiquity

Number portability will be implemented within designated areas, consistent with the competitive demand and regulatory directives. Calls to ported numbers will be dialable and completable from customers served by any end office, either within or outside the designated area. Switches in which the necessary capabilities to obtain the network address (LRN) are not available will use default routing to forward the call to a switch with the necessary functionality. Accordingly, all numbers within the designated area should be available for porting.

13.1.6.3 Directory Assistance

Directory Assistance (DA) will be provided in a portable environment in a manner not unlike it is today. That is, assuming location portability beyond NPA boundaries is not supported, DA for a given geographic area will continue to be accessible by dialing (NPA) 555-1212. The service might be provided by a neutral, third party rather than the incumbent local service provider, and competitive offerings [perhaps accessible through other dialed numbers; e.g., (NPA) 555-1X1X] will no doubt be available. Over time it may be advantageous to use the SMS as the source of listings for DA, assuming the necessary interfaces between the SMS and DA platforms can be supported. DA should be available regardless of the particular portability architecture deployed; it will therefore be supported by LRN and other architectures as well.

13.1.6.4 Repair Services

Customer trouble reporting and associated repair service will continue to be available from all service providers. The impact of portability upon these type services is related to the need to identify the end office switch serving the customer number associated with the trouble report. Accordingly, operations systems which support the trouble reporting and resolution activities will have to be modified to provide access to the network routing database where customer numbers are mapped to network addresses. The LRN proposal will support the easy identification of network locations associated with customer numbers to effect trouble isolation and repair.

13.1.6.5 Emergency Services

As described in Section 12.9 of this document, maintenance of emergency services (911/E911) in a number portable environment is dependent upon the availability of a dialable customer number at the Public Safety Access Point (PSAP). The LRN proposal meets this requirement as the dialable number, of the calling party, rather than the network address, is readily available.

13.1.7 NUMBER ADMINISTRATION

Number Administration scenarios are explored in Section 8 with the related provisioning impacts described in Section 9 of this document. The LRN proposal can be implemented independent of either administrative scenario, that is, either assignment of customer NPA-NXXs to specific service providers with only ported numbers contained in the SMS, or with customer NPA-NXXs assigned to a "pool" with all numbers contained in the database. In addition, the LRN proposal demands assignment and administration of the LRN itself; that is, the NPA-NXX-XXXX that identifies a particular end office switch. It is assumed that such assignment and administration will take place under the direction of the code administrator, and subject to processes and guidelines established by the industry.

13.1.8 CALL RATING

The manner in which calls will be rated in a portable environment and the associated complexity of the rating process is directly related to the method in which numbers are assigned and the extent to which location portability is permitted. If NPA-NXXs are designated for assignment only within a given rate center, and location portability beyond rate center boundaries is not allowed, call rating can be acommodated as it is today, based upon the known location (rate center) of the calling and called customer numbers. If these constraints are not maintained, additional rate related data – such as the identification of the specific rate center for the customer number – may have to be provided in the database record and the downstream rating process modified accordingly.

If location portability beyond rate center boundaries is supported, it would be advantageous to provide, in real time, the network address (LRN) of the calling party. AT&T believes that this need could be accommodated through use of the Jursisdictional Indicator Parameter (JIP), an existing SS7 ISUP parameter that would forward the NPA-NXX of the calling party switch. This data could be part of a modified AMA record and used to accurately rate the call.

To avoid such complexities, AT&T suggests that initially, number portability be implemented with location portability limited to within rate center boundaries and NPA-NXX assignments constrained to given rate center areas. With these constraints, call rating and its associated process are not impacted. Over time, if and when location portability is expanded and customer numbers do not directly indicate rate centers, the LRN architecture is fully capable of supporting the additional data and processing required to provide the necessary call rating.

13.1.9 TIMING AND AVAILABILITY

The necessary switch development to support LRN is currently being explored by several switch vendors. It is currently estimated that these developments, which include the use of a new trigger, the modified use of existing signaling parameters, and the necessary end office (GAP) processing can be available by 2Q97. Changes in signaling standards to reflect the modified use of existing parameters are now under consideration in the appropriate standards body (T1S1) and should be completed by 2Q96. Work on the requirements for the SMS has begun in several state workshops and should be completed to allow the deployment of an SMS consistent with the aforementioned 2Q97 date. It is further assumed that the necessary methods and procedures for the porting of calls and the provision of service to new customers, as well as other administrative processes will also be available by that time.

13.2 LANP Description

The Local Area Number Portability (LANP) proposal for the permanent implementation of local number portability (LNP) is offered by U.S. Intelco (USI), Stratus Computer, Inc. (Stratus), and Electric Lightwave, Inc. (ELI). While offered to address the immediate need for service provider number portability (SPNP), LANP also provides the call routing and feature transparency characteristics required to support location and service portability in the future.

13.2.1 General Description

The LANP call model proposal addresses requirements for both call routing and SS7/TCAP message routing in an LNP environment. LANP does not mandate the use of any specific triggering technology within switches to perform the call routing database query to obtain a network address for a call.

13.2.1.1 Call Processing General Description

With respect to call routing, LANP proposes:

I. Calls to portable numbers are queried using an N-1 trigger placement policy. Specifically, local ported calls are nominally queried in the originating local network. Where as, inter-exchange calls to ported numbers are nominally queried in the IC network. N-1 is just a policy for engineering triggers and LNP query-capable switches in a network -- LANP signaling facilities (forward dip indicator) insure that correct ported call processing occurs regardless of where in the call path the querying switch occurs. In either call type, terminating or fail-safe querying must also be supported to enable the donor switch or network to query and re-route the call to insure completion.

II. New LNP-specialized switch triggers are required to implement permanent LNP on a wide-scale. Existing triggering technologies (e.g. AIN 0.1 and IN), while capable of supporting limited LNP trials with work-arounds (i.e. trigger assists), are unsuitable for permanent use in LNP. LANP does not require any specific triggering technology or SSP-SCP message format be used -- either AIN or IN may be used as a basis for developing LNP-specialized triggers. LNP trigger requirements include: (a) interwork with a forward dip indicator (newly allocated bit in FCI); (b) should support 3, 6, and 10-digit match behavior; (c) provide an intra-switch look-ahead facility to determine if the CNA dialed is served in the current switch, and complete the call without a database query; and (d) populate forward call signaling parameters (defined in (3) below) with LNP SCP response parameters and pre-query CdPN value (CNA).

III. Subsequent to the LNP database query for call routing, a 10-digit network address (or network node address, NNA) is obtained from the database associated with the dialed portable number (or customer number address, CNA). The NNA is a placed in the CdPN parameter; the CNA is placed in a new (LNP-specialized) GAP parameter, and a forward dip indicator is flagged in the FCI parameter (specialized LNP use of a reserved bit within the FCI).

IV. Call processing resumes subsequent to the dip with call routing to proceed based on conventional 6-digit interpretation of the NNA per the LERG. In nominal circumstances (e.g. SS7/ISUP trunking), the new and modified call parameters (CdPN, GAP_{LNP}, and FCI) are required to be forwarded downstream the callpath in the IAM message to the terminating end-office. Non-LNP capable intermediate switches and networks are not impacted, and will correctly route the call, based on 6-digit examination of the CdPN parameter (unaware of the distinction of it containing an NNA value), and will forward the additional parameters downstream.

V. The NNA value associated with the CNA is assigned by the new serving local service provider (LSP) in the process of completing the service order to port the customer from their previous LSP. The NPA-NXX of the NNA unambiguously identifies the actual terminating end office switch for the intended subscriber, so calls may be direct routed using conventional 6-digit routing translations.

VI. At call termination, the serving end office recognizes the NPA-NXX of the NNA as a home NXX, and proceeds to interpret the incoming NNA (CdPN), and CNA (GAP) if needed, to determine the intended destination of the call.

VII. No one specific method of translating an incoming call to a ported number is mandated by LANP. Multiple methods of interpreting an incoming NNA may be implemented within different switching equipment (e.g. class 5 switch vs. MSC vs. ATM switch w/voice SVC) deployed and co-existing in an LNP area transparently to each other. For all intermediate (including querying) switches, the only requirement is that the NNA be a valid 10-d NANP LERG routable number. At the terminating end-office, for example, the NNA could be interpreted in at least the following three ways:

a) Split number address: NNA is opened on the switch and associated with the line, or the switch is otherwise able to translate the incoming NNA to the intended line.

b) Single number address: NNA is an LRN-like address, that is not line/DN associated. Consequently, the CNA is restored to the CdPN, and 7-d translated to identify the intended line. The CNA value is opened as the DN of the ported line. This is identical to LRN call processing.

c) Temporary local directory number (TLDN): The NNA is dynamically assigned by the subscriber's home network (home MSC/HLR) at the time of the LNP routing query, in conjunction the actual serving switch (VMSC), to that very call. The TLDN, once assigned, is uniquely associated with the call to the intended line whose parameters were indicated during the TLDN assignment process (e.g. IS-41 RouteReq). Once an incoming call is received to a valid TLDN, the TLDN value is de-assigned and able to be assigned for another call setup attempt. Incoming TLDN call processing in this scenario is identical to incoming autoroaming call delivery in a mobile switching environment.

LANP does not dictate the exact mechanism of incoming call processing at the serving end-office, but instead leaves this functionality as implementation detail for network switching vendors, and their customers, to engineer so as to best optimize their costs and availability of LNP conforming product. None of the modes mentioned above is essential to nor mandated by LANP, but are simply examples of modes that can technically co-exist and which may have value to different LSP industry segments.

VIII. LSP's are responsible for assigning NNA types and values to support their network, switch-types, and desired modes of ported line switch provisioning. LSP's independently choose their NNA types and values due to complete transparency in call querying, signaling, intermediate switch processing, and inter-company processes. Inter-company processes such as repair, service order admin, operator services, etc., function identically regardless of the type of NNA used.

13.2.1.2 SS7/TCAP Message Processing General Description

With regard to SS7/TCAP message routing, LANP proposes:

I. The LNP SCP's perform 10-digit routing of LNP-affected TCAP messages, to eliminate functional impacts to existing SS7 network elements (STPs and switches) related to TCAP message routing generated by LNP. TCAP messages employing portable number-based global title addresses or those who DPCs are derived assuming 6-digit interpretation of a DN (e.g. IS-41A), are routed via LNP SCPs where 10-digit global title translation (GTT) routing is performed. Affected applications include: CLASS (AC/AR, SLE, CNAM), LIDB/ABS, and IS-41.

II. TCAP messages requiring 10-digit routing are routed to an LNP SCP by changing the STP-resident 6-d GTT routing translations to the LNP SCP for NPA-NXX blocks opened for porting. Only TCAP messages for NPA-NXX's opened for porting are SCP routed.

III. The LNP SCP's deployed for 10-d SS7/TCAP message routing do not need to be the same physical SCP's queried by the switch network. The term 'LNP SCP' is used generically to refer to an SCP that hosts a copy of a portion of the LNP database that interconnects to the LNP administrative network to receive updates to that database. This functionality may migrate back to STP's or specialized STP-adjuncts.

IV. Both end-point (EO DPC) and gateway routing (STP DPC) options be supported by the LNP SCP's. The only difference between these two modes is whether the SCCP calling party id address is left as a global title or translated to a DPC+SSN. A third routing option should also be considered for implementation: GTT translation type replication. The table below (Table 1 - SCP-based 10-digit TCAP Routing Options) summarizes these options for SCP-based 10-digit routing of TCAP messages.

Table 1 - SCP-based 10-digit TCAP Routing Options

Routing Method	First LNP SCP Returns	Final LSP Routing	Number of GTTs	Comments
Originating	Final DPC.	Direct DPC	2 (originators	• Least # of GTT's.

DPC Routing		routing at STP.	STP, originator's SCP)	• All LSP's know DPC's of other LSP's facilities.
Gateway Routing to LSP	MTP: DPC of LSP gateway STP. SCCP: CNA-GTT.	Final 10-d GTT done at dest LSP SCP.	4 (originator's STP, SCP, destination STP, and SCP)	• Most # of GTT's. • Only destination LSP knows DPCs for their facilities. • All intermediate LSP's route to destination STP gateway.
Replicated GTT	MTP: DPC of LSP gateway STP. SCCP: NNA-GTT.	Conventional 6-d GTT done at dest STP.	3 (originator's STP, SCP, and destination STP)	• Moderate # of GTT's. • Single 10-d CNA->NNA GTT conversion at originating LSP's SCP. • Conventional 6-d GTT thereafter to destination. • Requires additional GTT routing tables in STPs for new TT's (TT's for NNA's).

13.2.1.3 Background

LANP was originally developed in conjunction with the Seattle 'Proof-of-Concept' number portability trial conducted in Washington state starting in 10/94. At that time, the focus of the effort was on trialing and potential immediate deployment as an interim database approach – one that would require only minimal, if any, switch functional enhancements to support. This constraint dictated the use of existing triggering (AIN) and translations capabilities, and led to the development of the split number addressing concept used throughout the Washington trial. Split numbering assigns line-specific NNAs that enable incoming calls to ported numbers to be completed using existing 7-d switch translations capabilities (the NNA was opened on the switch as a DN of the ported line), and without requiring a terminating dip to perform a parameter swap to restore and translate on the CNA.
As the final phase of the Seattle trial was underway in mid-1995, the LANP effort evolved to focus more directly on permanent deployment of LNP with a view to maximizing the breadth of participation in LNP to all industry segments. This led to a major enhancement to LANP, that multiple interpretations of an NNA were possible on a terminating end-office and could be supported transparently to each other within the previously established signaling and routing facilities proposed by LANP. It was not necessary to insist that the terminating end-office interpret an incoming NNA only as a split number address, but that an LRN-like address, as well as a TLDN-like address (for dynamic IS-41-like call routing), were equally possible. The LANP proposal from the outset included transmission of the CNA in GAP, initially for call recording purposes, but that it's use permitted an LRN-like GAP-CdPN swap to occur at the terminating switch without changing the signaling. If the NNA is opened on the switch and associated with a specific line, then the call could be completed without consulting the CNA in the GAP. If the NNA is instead an LRN, then the CNA from the GAP would be restored as the CdPN prior to performing line translation. The LSP would assign the type of NNA and NNA value based on it's own determination of the ported number addressing mode

used: for that switch-type, entire network, or even perhaps by customer or line-type.

13.2.1.4 Network Node Address

Since LANP does not mandate how specific NNA interpretation is performed in the serving end-office of a ported line, either the CNA or NNA values may be used to translate the incoming call to the intended subscriber facilities -- thus there are two general classes of ported line addressing modes, as identified in Table 2 - Basic Wireline Addressing Modes: Single & Split.

Table 2 - Basic Wireline Addressing Modes: Single & Split

Addressing Mode	General Description	Line Translation Based On
Single Number	A shared (by all lines on switch, of a sub-group of lines) NNA is placed in CdPN. The dialed ported number is placed in another parameter (GAP) and restored into the CdPN at the terminating end-office.	CNA
Split Number	A line/subscriber-specific NNA is placed in CdPN. The dialed ported number (CNA) is placed in another parameter (GAP), but not used for routing or translations.	NNA

While single and split number addressing modes appear to be distinct, in practice the basis on which NNA's may be allocated and assigned to serve CNA's form a spectrum of possible NNA types, as identified in Table 3 - Possible NNA Types and Implied Addressing Modes.

Table 3 - Possible NNA Types and Implied Addressing Modes

NNA type	Assignment Basis	Addressing Mode Used
Switch-specific	One per switch: a single NNA for all subscriber's served off of the switch.	Single (LRN).
Rate center-specific.	One per rate center per switch, used where NNA (or LRN) values are used for rating, in lieu of CNA.	Single (LRN).
Reseller-specific	One per reseller per switch	Single (LRN).
Customer type-specific.	One per customer-type per switch, e.g. residential, small business, large business, interconnect, etc.	Single (LRN).
Large end-user specific.	One per qualifying end-user. May or may not be associated with line-side facilities.	Split (if facilities associated), otherwise single (LRN).

Line-specific.	One per line/line-group. Is normally associated with line-side facilities.	Split or single.
Number-specific.	One per CNA. Is normally associated with line-side facilities.	Split or single.
Call-specific.	Dynamically associated with called party/session via query to called's HLR.	Dynamic (TLDN).

While there are two basic addressing modes (single and split), the allowed combinations of opening up CNA, NNA, and both CNA/NNA values on a serving end-office suggests three possible modes for provisioning ported lines on the serving end-office. See Table 4 - Ported Line Provisioning Modes and Implied Addressing Mode.

Table 4 - Ported Line Provisioning Modes and Implied Addressing Mode

Addressing Mode	Provisioning Mode Opened on EO? CNA	NNA	NNA Specifies	Notes
Split	No	Yes	Line	Line is opened with NNA on switch, CNA is provisioned as the CgPN generated on outbound calls from line.
Split	Yes	Yes	Line	Both NNA and CNA opened, NNA for incoming routing and translation. CNA for CgPN generation and dip suppression on intra-switch routing.
Single	Yes	No*	Switch only (e.g. LRN)	CdPN just gets call to EO. EO obtains dialed number (via another parameter or reconstruction) and performs translation on dialed number. CNA only is opened.

13.2.1.5 Diversity of Serving Network/End-Office Functionality

LANP advocates diversity in the way LSP's and their networks assign, use, and interpret NNA's in an LNP environment, while defining a standard NNA format (10-digit, LERG routable) and signaling interface between networks and network elements that makes this diversity transparent. The purpose of this principle is not to multiply the number of implementation options that a given vendor must support in their equipment, but multiply the number of types equipment and equipment vendors that could co-exist in an LNP-conforming market. Different LSP's will employ different types of equipment (e.g. class 5 end-offices, MSC's, broadband) as well as have widely varying business and technical objectives. Some may find that certain NNA assignment paradigms (e.g. one per customer account per switch) better meet their OSS (e.g. provisioning and billing systems) requirements than others. Those that employ multiple vendors supported by a common OSS will likely establish a consistent paradigm for NNA allocation and assignment for consistency of OSS implementation (e.g. one per reseller per switch).

Within the Illinois Commerce Commission (ICC) LNP workshop, three different new LNP-specialized triggers have been defined that will be developed and utilized simultaneously with the initial deployment of LRN in the Chicago (MSA-1) area. Each switch vendor will support one of the three triggers. The reason there are three was that no one suitable LNP trigger could be developed in the same general timeframe from all of the switch vendors. Diversity was the key, in this case, to minimizing time and maximizing participation. Complexity was added to the LNP SCP to support (separately or together) all three query/response message formats, but this was viewed as an easy tradeoff for switch availability and therefore LSP participation.

Also in the ICC LNP workshop, carrier participants have expressed a diversity of views regarding their preferred basis for assigning LRN's (NNA's), such as assigning one LRN per reseller per switch, or one LRN per NPA served per switch. This has led the ICC LNP generic requirements subcommittee to specify that conforming switches must support at least two LRN's per switch, with the likely practical limit being substantially greater (> 100).

13.2.1.6 Conservation of Numbering Resource

LANP offers not only NANP preservation, but with wide-scale deployment the potential to defer NANP exhaust through increased resource utilization. LANP's NANP conservation stems from it's treatment of CNA's and NNA's as separate numbering plans. This separation relies on the use of a forward dip indicator to flag, in effect, the type of number (CNA vs. NNA) contained in the CdPN field at any point in the callpath. The forward dip indicator, when present, shows that an LNP database dip has successfully been performed thereby indicating that an NNA is contained in the CdPN field.

The NANP today is only sparsely utilized because a common numbering plan is used for assignment of both customer numbers (CNA's) and line numbers (NNA's) functions. The fill rates for metropolitan areas experiencing NPA splits ranges from 40%-80%. In many cases, CNAs are assigned where there is no dedicated line (e.g. DID blocks, hunt groups) and conversely, NNAs are assigned to identify individual lines and trunks which are not directly dialable. However, in today's NANP, once a number is assigned for any use, it can not be used for any other function. In addition, small rural end-office may not use most of an entire NXX block, but once the NXX is assigned, it can't be moved. Consequently, there is significant waste in the existing NANP.

By decoupling the number plans, both plans will be more efficiently utilized, thereby enabling higher fill rates in both plans. Significant resource recapture can occur if CNA number pooling is used when an area becomes LNP-capable. While the NNA plan will continue to strand NNA numbers in rural EO's, the CNA plan can recapture all stranded CNA numbers and make them available for the whole local area. The decision to pool CNA numbers, and use them for new service orders in addition to number porting, is a policy decision and is not inherent in LANP. LANP enables this administrative policy option to exist.

Also, CNAs for which there are no lines (such as DID blocks and hunt numbers) will no longer deplete available NNA numbers, so they too may be better utilized. Because numbers in each plan are functionally specialized and allocated independently, numbers in both plans will be far better utilized than today.

Demands for office codes for new LEC switches in an LNP environment are effectively requests for NXX's in the NNA space and will not necessarily require NPA splits in the CNA space. New NPA's in the NNA space may be transparently added since they are not dialable. If a new NNA NPA is introduced into an area to affect a rating split along geographic boundaries, an NPA split of CNA's can be avoided if other facilities (call recording, billing, rating) required for inter-rate center location portability are deployed. While converting a mass block of non-ported numbers to use the LNP database to avoid an NPA split of dialable numbers is not a small effort, compared to the enormous end-user costs and disruptions of forced number changes there is a potentially compelling case for end-user benefits in using LNP to avoid CNA NPA splits. Consequently, subscribers may be insulated from demands in the NNA space, even if new NNA NPA's are required. CNA NPA splits need no longer occur due to the creation of new NNA NPA's.

13.2.1.7 Comparison with Other Proposals

While both LANP and LRN approaches have evolved since their original proposals (in the form of INC contributions), there is now commonality with respect to signaling and routing recommendations, and requirements for new LNP-specialized triggers. Consequently, LANP is fully compatible with LRN. LANP, resulting from the evolution (discussed in section 13.2.1.3), is functionally a superset of LRN. It's a superset is the sense that LANP effectively relaxes the incoming ported call processing functionality mandated by LRN (single number addressing), and recognizes that imposing this level of detail of end-office functionality is not necessarily ideal for all potential participants in LNP, nor does it anticipate the proliferation of network and switch technologies that will occur with local exchange competition and the advent of a network-of-networks structure of the PSTN.

Wireless participation in LNP is essential for access to local markets for potential displacement services, such as PCS. Wireless, as well as other new network technologies (e.g. broadband), may find that the paradigm of assigning NNA's on a per subscriber or per terminal basis to be more meaningful than assigning them on a per switch basis. The concept of a central office switch will itself undergo a radical transformation over time with the integration of switching and transport technologies.

Philosophically, it's essential that LNP standards not work contrary to the purpose of enabling open local exchange competition and the inherent diversity of local service offerings ultimately generated. Therefore, LNP standards should not artificially constrain or mandate functionality in switches not essential to the inter-operation of LNP amongst competing LSP's. Standards should define inter-network and inter-element interfaces to guarantee inter-operation, but should not constrain the internal implementation of those interfaces in the marketplace.

It is recognized, on the other hand, that the diversity of NNA interpretation and related switch/network functionality advocated by LANP is not as relevant and valuable when aggressively planning the first stage of permanent LNP deployment in the PSTN. The commendably aggressive timeframes to which leading states such as Illinois are planning on deploying LNP (starting in Q4 1996), justifies focusing on the requirements of the immediate constituents for that deployment: wireline LSP's using class-5 central office switches. Given the switch vendors willingness to develop common new LNP-specialized functionality in support of the deployment schedule lessens the need to consider employing multiple addressing modes that might have enabled existing diverse switch implementations to be utilized within a common approach.

Consequently, the selection of the LRN approach for permanent implementation of LNP in those states should not be viewed as a rebuttal of the diversity principle for wide-scale LNP participation, but instead reflects the practical value of defining initial implementation specifications normally beyond the scope of industry standards that was justified to establish consistency of impacts to areas such as OSS's within a homogeneous group of initial participants. Nothing technically precludes these initial LRN implementations from transparently evolving to support more LANP-like functionality for a broader set of participating LSP's, if they so desire. There is the danger, however, that by not recognizing the diversity principle even where initially deferred, that such selections could be used by the initial participants and their vendors to control access to those local markets from a broader set of future participants.

However, it is not accurate to characterize LANP as either a 'dual domain' or 'split number' approach.

The concept of 'dual domain' is truly generic to LNP. Every portable number requires a routing address (NNA) separate from the portable number (CNA) itself, in order to retain 6-digit call routing functionality in the PSTN. LANP advocates that NNA's be considered a separate address space from CNA's. NANP resource conservation requires this distinction be made to avoid consuming, on average, more than one number per ported customer. Without this distinction, NANP resource is wasted, regardless of whether the NNA is shared amongst multiple subscribers or not.

In the Illinois Commerce Commission (ICC) LNP workshop Generic Requirements subcommittee, the switch generic requirements for LRN implementation specify that LRNs are allocated and assigned out of a separate number space than are DN's, and are stored in a separate LRN table in the switch. Consequently, the same 10-digit value may be used as both an LRN and a DN. This separation, as originally proposed in LANP, is affected through the interpretation of the forward dip indicator (called the NP query done indicator in LRN) in the FCI parameter. This bit is equivalent to an 11th address digit in the NANP, and effectively identifies the number space in which the 10-digit number is assigned. The forward dip indicator in LANP has always been proposed for two purposes: redundant query suppression and number space separation. While originally proposed in LRN for query suppression purposes, it nonetheless serves the same additional purpose as in LANP in effectively separating the numbering spaces.

While LANP historically has focused on use and advocacy of the split number addressing mode, this is an historical artifact as is discussed in section 13.2.1.3.

Inter-company processes (e.g. repair, service order admin, etc.) in LANP are identical to LRN -- the CNA continues (as the DN is today) as the primary key exchanged between entities to identify the subscriber or service in question. Where required, the LNP database is consulted to obtain the NNA for the CNA to verify call routing and database concurrency. The only potential difference between the two static addressing modes (split and single) lie in the switch-related OSS's which are intra-company.

13.2.2 Architecture Description

Figure 1 - LANP Architecture Reference illustrates the basic types of facilities and interfaces nominally deployed within a participating LSP and between a local neutral third party LNP administrator (or LNASC). Included in this architecture are the network switches, LNP routing database (SCP), signaling facilities, and administrative systems typically involved in an LNP environment. LANP is fully consistent with the general architecture described in Section 7.

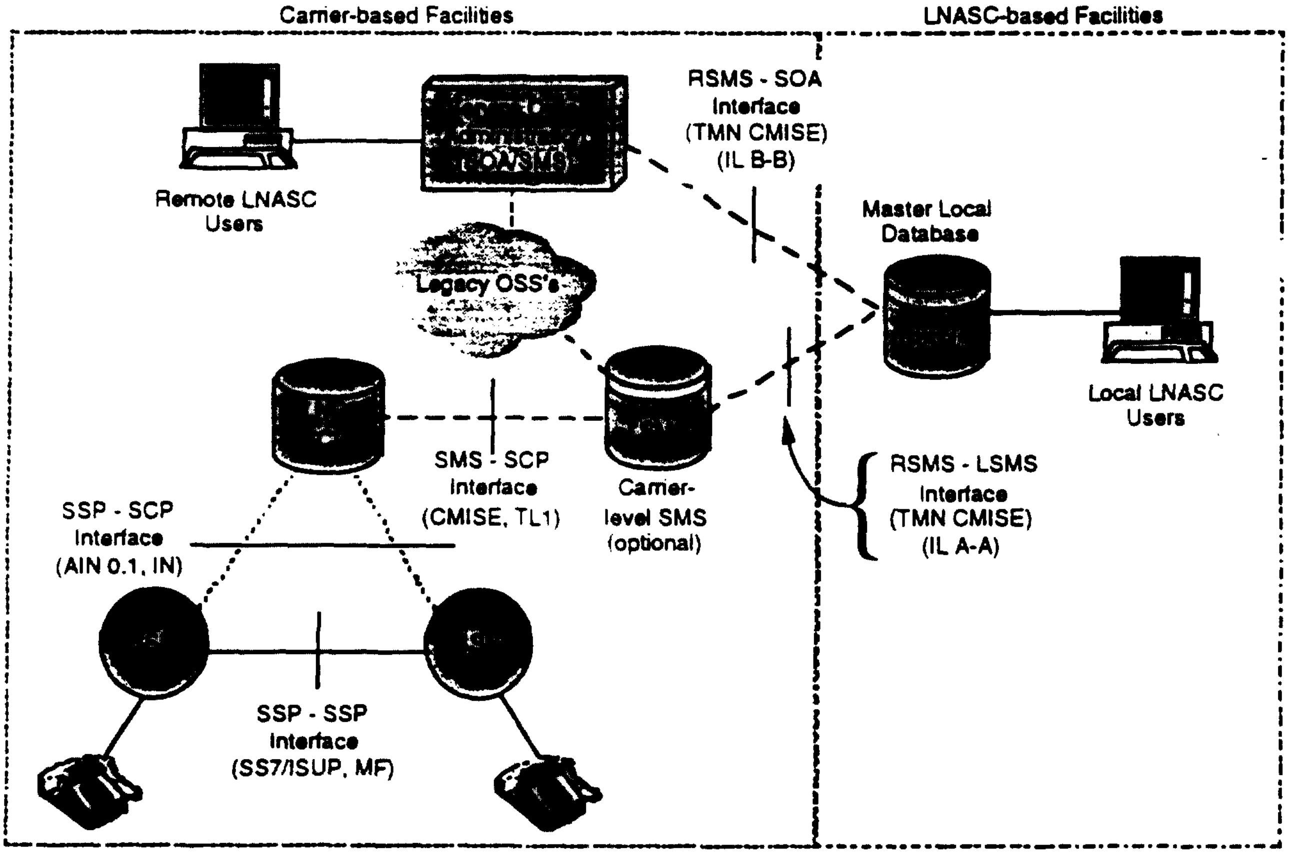

Figure 1 - LANP Architecture Reference

13.2.3 Method of Operation

First, LANP's signaling recommendations are described as preparation for the illustrative call flows in the following sections.

13.2.3.1 Signaling

Subsequent to an LNP database response for a call to a ported number, the following parameters are modified and use in subsequent call processing:

I. CdPN contains the called party's 10-digit NNA.

II. GAP, marked as a new LNP type, contains the dialed CNA.

III. The forward dip indicator bit in the FCI is true.

IV. Optional location portability recording parameter: Generic Digits Parameter (GDP), marked as a new LNP called-party location type, contains the called party's location, service provider, RAO, and/or rating identifier (formatted as either a V&H, zip-code, or other). The GDP, flagged as a traveling class mark (TCM), appears as the TCM parameter in the SSP-SCP message formats defined in AIN 0.1. The GDP is specified current in ISUP to contain various subscriber information, such as account and authorization codes. The use of this parameter for end-user information for LNP is consistent with it's current uses, and due to it's interworking with AIN 0.1 could be accommodated with modifying the SSP-SCP message formats. The LNP-specialized trigger would be coded to populate the return GDP from the SCP (in the TCM parameter) as a new LNP-type. This would enable the database to provide necessary additional call recording information needed for location portability along with the network routing address.

The following parameter is proposed to be generated in call origination from a ported line in support of AMA call recording requirements for location portability.

I. JIP contains the NPA-NXX of the calling party's NNA.

13.2.3.2 Call Flows

IntraLATA Calls Between LNP Participants

The example in Figure 2 - Sample Local Call to Ported Number' illustrates a typical local ported number call scenario. In this case, three LECs (LSPs) serving a sample local region (with CNA & NNA NPA of 206) are participating in LNP. Subscriber 1 (Sub-1, bottom phone) has ported his number (812-1234) from LEC-2 to LEC-3. Originally, LEC-2 served this subscriber from it's 206-812 (this switch's NNA office code) end office, where his CNA and NNA were implicitly one and the same prior to porting. In porting the 812-1234 number to LEC-3, it assigned a line to Sub-1 off of it's 206-623 EO, and assigned an NNA for the line of 623-9867.

Also in this example Subscriber-2 (Sub-2, top right phone) has ported his number (623-9867) from LEC-3 to LEC-2. Sub-2 is now served off of the 206-812 EO, and is assigned an NNA of 812-1235. Note that in this example, Sub-2's NNA number (623-9867) is the same as Sub-1's CNA number. This demonstrates the full re-use and independence of CNA and NNA numbers.

The steps in a call to Sub-1 are:

1. A call is placed to 812-1234 from a phone in LEC-1's network. The number dialed hits an LNP trigger in the originating network/switch (either a 206 or 206-812 trigger) which causes a query to be launched to the LNP SCP serving LEC-1.

2. The SCP translates the CdPN from it's CNA value of 206-812-1234 (original dialed number with 206 NPA added by the switch) to the associated NNA value for Sub-1 of 206-623-9867. The querying switch updates it's call parameters in response as follows: CdPN = NNA 206-623-9867, GAP_{LNP} = CNA 206-812-1234, FCI (forward dip indicator) = true.

3. LEC-1's originating switch then routes the call based on the NNA value in the CdPN parameter, and routes the call via the most direct route to LEC-3's 206-623 EO. No subsequent LNP triggers are encountered on the NNA value (206-623 is also a valid CNA NXX) due to the FCI indicating that the CdPN contains an NNA and has already be queried.

4. The 206-623 EO receives and interprets the incoming call based on one of the two wireline addressing modes (single or split, described in 0 above). The call is completed to Sub-1's line.

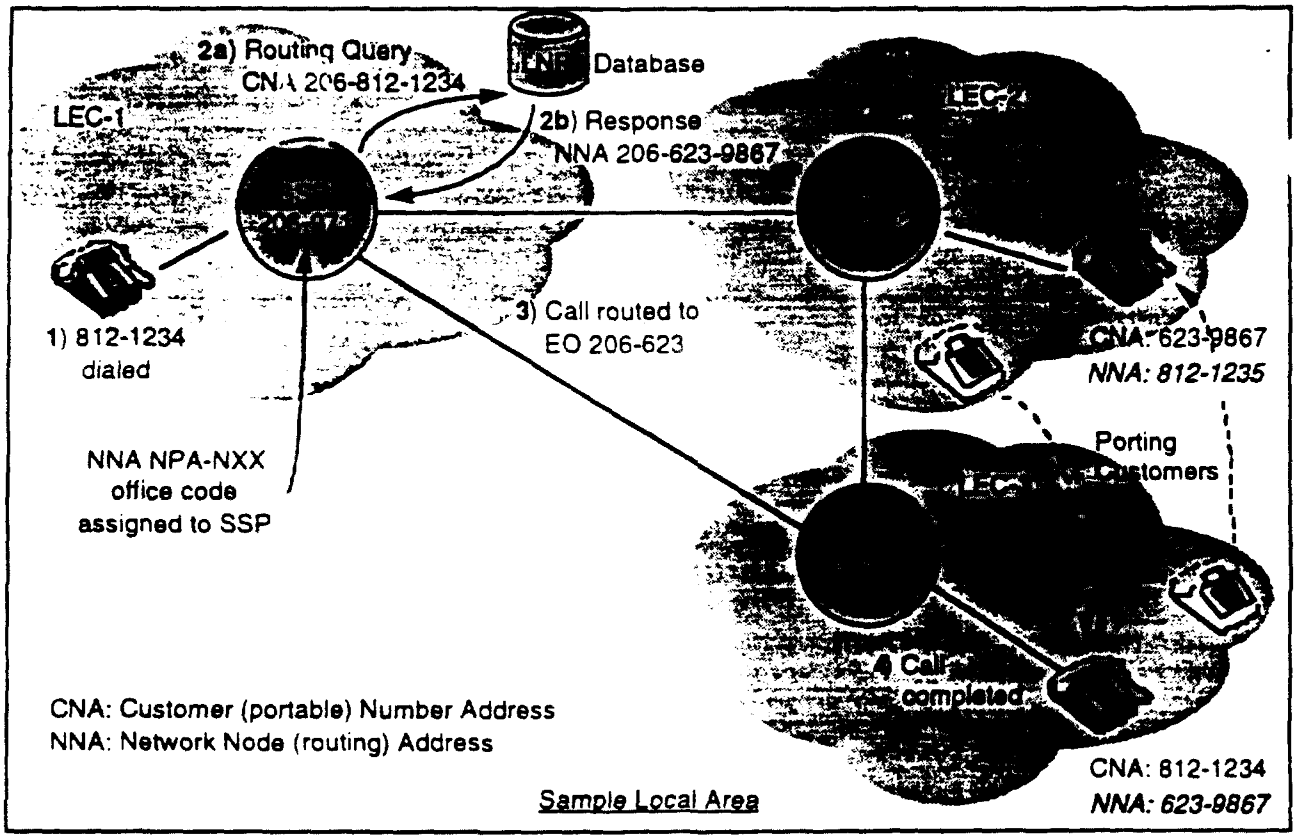

Figure 2 - Sample Local Call to Ported Number

IntraLATA Ported Call from Non-LNP Originating Network

Figure 3 - Sample Local Call from Non-LNP Network' illustrates a similar situation as in prior example above with the exception that here LEC-1 is not LNP-capable (i.e. an old domain network) and is therefore not able to dip calls prior to routing. In reality, any number of old domain networks (both EC and IC) must be accommodated in deploying LNP. The ability to route the call based on CNA value (CNA NPA-NXX) may introduce routing in-efficiencies but must always succeed nonetheless. The same subscribers and phone numbers are used as above:

1. A call is placed to 812-1234 from a phone in LEC-1's network. LEC-1's network is not LNP-capable and is not able to recognize the 206-812 prefix as requiring an LNP query.

2. LEC-1's originating switch routes the call based on the 206-812 CNA prefix to LEC-2, where the 206-812 NNA is assigned.

3. Upon receiving the call at LEC-2's 206-812 switch, the number dialed (forward dip indicator is off) encounters an LNP trigger which causes a query to be launched to the LNP SCP serving LEC-2. The SCP translates the CdPN from it's CNA value of 206-812-1234 to the associated NNA value for Sub-1 of 206-623-9867, as before.

4. LEC-2's switch now routes the call based on the NNA value in the CdPN parameter to LEC-3's 206-623 EO. Here the 206-812 EO is acting as a tandem in redirecting the call to the correct terminating switch. In general, the first new domain switch the call encounters will dip the call and re-route correctly from there. This example is worst case by assuming the 206-812 switch is direct trunked to LEC-1. Old domain (non-LNP conforming) networks which are direct trunked to new domain EO's will encounter re-routing for calls ported from those switches.

5. The call is completed to Sub-1's line.

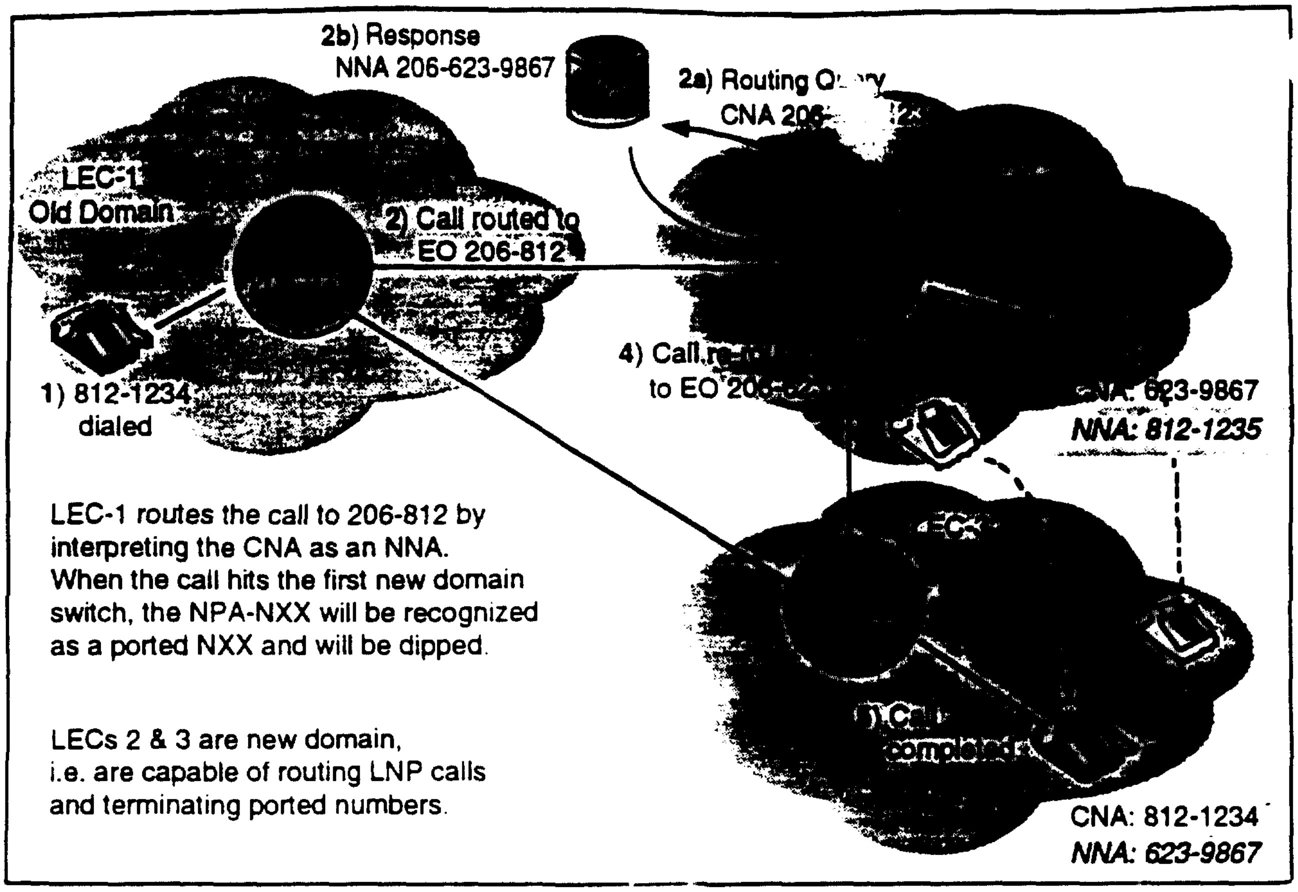

Figure 3 - Sample Local Call from Non-LNP Network

13.2.3.2.3 IXC Call

Figure 4 - Sample Inter-Exchange Portable Call' illustrates a sample inter-exchange toll call to a ported number, where the IC is LNP-capable (i.e. new domain). Generally, inter-exchange calls will not be dipped by the originating LEC, even if it's a new domain LEC. Instead an N-1 policy is supported for trigger placement, where conforming IC's perform dips. In this example, a toll call is placed from LEC-1 (708-312 switch) to a ported number served by LEC-3 in another local region:

1. A call is placed to CNA 206-812-1234 from a phone in LEC-1's network. The CNA NPA-NXX prefix does not match any provisioned LNP triggers in the originating switch/network (i.e. it's not a locally ported number).

2. The call is routed to the IC based on the subscriber's PIC (presubscribed inter-exchange carrier), with the CNA value in the CdPN parameter.

3. Upon receiving the call, the IC's POP switch encounters an LNP trigger (the forward dip indicator is off) which causes a query to be launched to the LNP SCP serving the IC. The SCP translates the CdPN from it's CNA value of 206-812-1234 to the associated NNA value for Sub-1 of 206-623-9867, as before.

4. The IC network routes the call based on the NNA value in the CdPN parameter which identifies LEC-3's 206-623 EO. The IC must forward all LNP-modified signaling parameters to LEC-3 (the terminating LEC).

5. The call is completed to Sub-1's line.

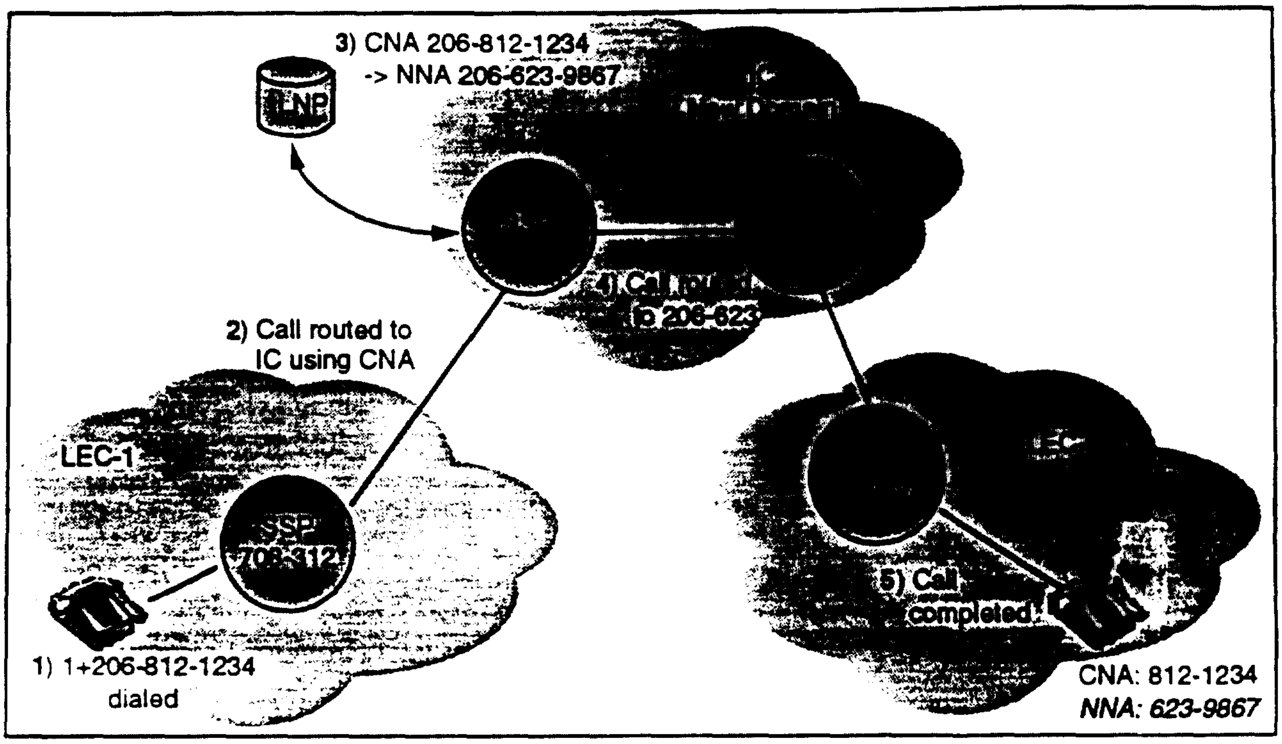

Figure 4 - Sample Inter-Exchange Portable Call

13.2.3.2.4 Call to Mobile Subscriber using Dynamic Addressing

Figure 5 - Sample Call to Portable Mobile Subscriber using Dynamic Addressing' illustrates the use of dynamic addresses for calls placed, in this example, to a mobile ported subscriber. In this scenario, the subscriber's wireless LSP has elected to flag this subscriber's CNA for dynamic assignment. No NNA has been pre-assigned in the LNP database, the NNA instead is requested dynamically via SCP-to-HLR query to the subscriber's LSP. The NNA, once obtained, is treated as a TLDN when the incoming call is received at the visiting MSC.

1. Caller (presumably wireline, otherwise a native IS-41-based LNP mechanism might be employed wireless-to-wireless) dials a mobile ported number (812-1234) from LEC-1 network.

2. LEC-1 network triggers based on CNA, and dips into LNP SCP. LNP SCP record for the CNA indicates dynamic NNA assignment. An IS-41 RouteReq is launched from LEC-1's LNP SCP to the subscriber's HLR. The HLR obtains a TLDN, in consultation with a VLR if roaming, and returns the TLDN to the querying LNP SCP. The LNP SCP returns the TLDN as the NNA, as though it had the TLDN in the database.

3. LEC-1 routes the call outbound with the TLDN as the NNA, the other LNP call parameters (GAP_{LNP} and FCI) are forwarded as well since LEC-1 is unaware of the nature of the destination network, nor that the NNA value is really a TLDN. The TLDN routes the call to the serving MSC for the subscriber.

4. Upon receiving the incoming call, the serving MSC associates the incoming TLDN with the CNA of the subscriber (previously setup via the IS-41 RouteReq). The other LNP call parameters (GAP_{LNP} and FCI) may or may not be utilized with the MSC if forwarded via ISUP. If the interconnect facilities are inband (e.g. DTMF or MF), the trunk group at the LEC-1's AT is class marked to outpulse the CdPN as the called party number. The subscriber's terminal is paged and presumably answers the call.

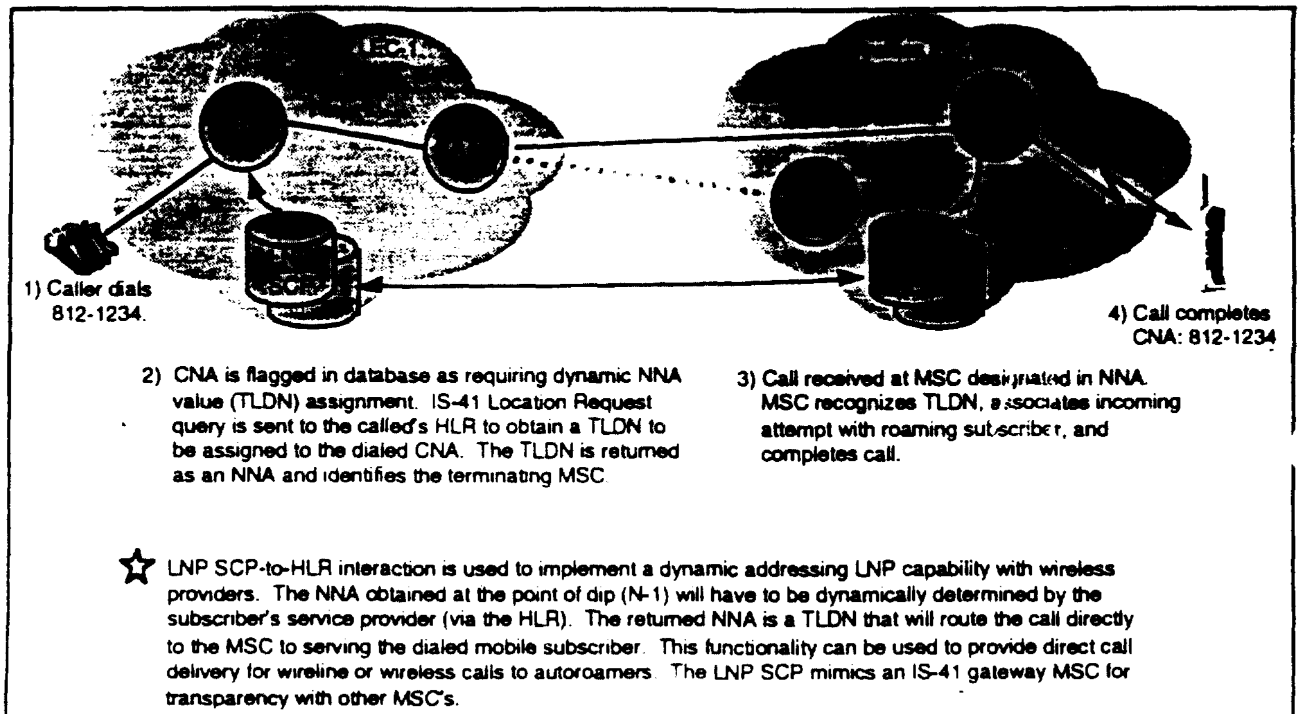

Figure 5 - Sample Call to Portable Mobile Subscriber using Dynamic Addressing

13.2.3.3 TCAP Message Flows

Figure 6 through Figure 8 illustrate the three possible TCAP message routing options described in Table 1 - SCP-based 10-digit TCAP Routing Options' for implementing 10-digit message routing in an LNP environment. Figure 9 - Example: LIDB Query from Non-LNP Network' illustrates that TCAP queries (LIDB/ABS in this example) from outside the local LNP area can be routed properly via the donor network similar to the way donor networks are required to provide fail-safe (i.e. terminating) routing for calls.